Editor's Introduction

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The Thirty-Third Annual Policy Conference of the Federal Reserve Bank of St. Louis was held October 20-21, 2008. Since their inception the Bank's annual conferences have been labeled *policy* conferences—yet, they also are *research* conferences. Each conference has focused on an aspect of contemporary economic research that is useful to policymakers.

The 2008 conference explored the concept and measurement of "potential" output. This concept is central to macroeconomic policymaking because policy decisions are driven, at least in part, by estimates of two concepts: "Is real output greater or less than potential?" and "Is real output growing more or less rapidly than potential?" The answers to these questions are central to policy decisions.

The output gap features prominently in the famous Taylor rule. It also is featured in inflation-forecasting policy models of the type popularized by Lars Svensson, both as an input to the inflation-forecasting process and as part of the policy authority's loss function.

WHAT DO WE KNOW (AND NOT KNOW) ABOUT POTENTIAL OUTPUT?

The first two conference papers address the concept of potential in the context of Real Business Cycle and New Keynesian macroeconomic models.

The first paper, presented by Susanto Basu and John Fernald, addresses our knowledge in models of the concept of potential output. The authors focus on two concepts—(i) potential output as the long-run trend in output, largely ignoring fluctuations around the trend; and (ii) potential output as the level of output attainable today in two cases: first, if wages and price are fully flexible, that is, adjust immediately to their frictionless equilibrium values, and second, if wages and prices are sticky, that is, slow to adjust to the new equilibrium values. The authors argue that the first concept may be useful in studies of long-run economic growth and development, where fluctuations around the trend are of secondary interest, but it is inappropriate to *assume* such behavior in the study of business cycles. The second concept focuses on technology shocks to the economy, that is, shocks that affect productivity either within individual firms or in entire markets. Generally, a negative shock reduces the level of potential output because it reduces the maximum amount of capital that the market economy, in general equilibrium and with flexible prices, will *choose* to use in production. Necessarily in this case, if prices and wages are fully flexible, actual output will track potential—the economy is in a continuous general equilibrium position conditional on the amount of physical capital available— and hence the gross domestic product (GDP) gap fails to be a well-defined concept in such models. When price and wage stickiness exists in a New Keynesian–style model, a negative shock decreases

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actual output. If potential is taken to be the flexible-price, continuous-optimization level of output, then the GDP gap is positive. The authors conclude that a two-sector, rather than one-sector, model is necessary to capture the economy's behavior because technology trends and shocks have different effects on the production of consumer and producers' durable goods. In his commentary, Rodolfo Manuelli lauds the direction of the paper—toward making more explicit in the context of models those assumptions that underlie policy analysis—but argues the capital deepening suggested by the Basu and Fernald model is fragile: The model's correspondence to the data varies across time periods. Further, small changes in production technologies between sectors (indexed by the capital share of output) can easily worsen the model's correspondence to observed data. In general, he argues, Basu and Fernald's results will remain difficult to interpret until embedded in a more detailed model.

ISSUES ON POTENTIAL GROWTH MEASUREMENT AND COMPARISON: HOW *STRUCTURAL* IS THE PRODUCTION FUNCTION APPROACH?

The second of the conference's theoretical papers was presented by Christophe Cahn and Arthur Saint-Guilhem. In an ambitious analysis, they embed a production function definition of potential output within a large-scale dynamic stochastic general equilibrium (DSGE) model and calibrate separate versions of the model to U.S. and euro-area data. The authors seek to provide a quantitative and comparative assessment of two approaches to potential output measurement, specifically, the DSGE model and the traditional Solow-style production function approach. The authors conclude that production function approaches are likely to overstate the role of structural factors in explaining cross-country differences in potential growth, relative to the differences in shocks across countries through time. In his commentary, Jon Faust emphasizes the value to policymakers that will arise as newer macroeconomic techniques, including DSGE models, are integrated into (but do not replace) a policy-formulation process based on older, more traditional concepts. Further, DSGE models likely will not be brought into the policy process until economists can compare and contrast within the models both production function–based and Real Business Cycle flexible price concepts.

PARSING SHOCKS: REAL-TIME REVISIONS TO GAP AND GROWTH PROJECTIONS FOR CANADA

Two papers at the conference (this paper and Anderson and Gascon, below) used vintage "real-time" data in their measures of potential output. In the first of these papers, Russell Barnett, Sharon Kozicki, and Christopher Petrinec of the Bank of Canada explore a new database that contains both vintage data on observed (published) real output and projections by Bank of Canada staff for 1994-2005. The output gap has played an important role in the conduct of monetary policy discussions at the Bank of Canada, largely within a New Keynesian framework. Vintage data are crucial to analysis and policymaking in this framework because, as Basu and Fernald emphasize in their contribution, the behavior of inflation in such models is determined by next-period expected inflation and by the gap between real output and potential output—measures strongly affected by data revisions. The authors focus on the dynamic updating process in which shocks and revisions to observed real output cause changes to projections of both future output and the output gap. In his commentary, Gregor Smith emphasizes that the Bank of Canada's process through which potential output entered policy discussions had two distinct segments: the extended multivariate filter and the Quarterly Projection Model. An identification issue arises regarding when and to what degree estimates of potential should be smoothed: Should estimates of potential be smooth and the response of policymakers to output gaps rapid, or should estimates of potential be volatile and the response of policymakers muted?

THE CHALLENGES OF ESTIMATING POTENTIAL OUTPUT IN REAL TIME

Practical monetary policymaking requires empirical measures—and forecasts—of potential output. Two of the conference's papers addressed this essential issue. In the first of these, Robert Arnold of the Congressional Budget Office (CBO) explains its methods for measuring and projecting potential output. The CBO's published measure is the "gold standard" among policymakers and academic economists and likely is the most common measure used in empirical research. Arnold emphasizes that potential is not a technological ceiling on the economy's production; rather, it is a measure of the maximum *sustainable* output. Attempts by policymakers to push actual output above potential output will result in supply-side pressures on labor, natural resource markets, and capital, culminating in unacceptable inflation. In addition to the maximum long-run sustainable output level, Arnold argues that potential output simultaneously should be an estimate of the trend in GDP. In combining these two requirements, Arnold imparts a distinctly long-run flavor to his measure—a flavor that tastes of both the two potential output concepts discussed by Basu and Fernald and Cahn and Saint-Guilhem in this issue. The principal driving factors of potential output are labor force growth, capital investment (capital deepening), and gains in total factor productivity. In his commentary, Robert Tetlow notes that Arnold's analysis is similar to an analysis on the same topic published in 1979 in the *Carnegie-Rochester Conference Series* and asks why 30 years of econometric and macroeconomic research appear to have affected the CBO's procedures so little. His conjectures are two. First, the CBO's underlying macro framework is distinctly Keynesian; that is, the majority of economic fluctuations come from shocks to aggregate demand, not shocks to technology and aggregate supply. Second, a large and detailed framework built within the Keynesian paradigm assists the CBO in answering in short order a wide range of questions posed by policymakers.

TRENDS IN THE AGGREGATE LABOR FORCE

The second paper of the conference to address empirical measurement of U.S. potential output was presented by Ken Matheny, senior economist at the St. Louis forecasting and consulting firm Macroeconomic Advisers. Matheny explains why trend growth in the labor force is the key determinant of trends in employment and in potential GDP. Perhaps the most difficult aspect of such projections is tying labor force participation rates to demographics, including fertility and current life expectancy. Matheny explains why recent highly pessimistic forecasts might be too gloomy and why labor force growth might be stronger than anticipated. Among the important contributing factors are life expectancy, household net worth, and the unemployment rate. The model suggests a pronounced upward shift in the labor force after 2011, due largely to higher-than-anticipated participation rates among older persons. If this occurs, not only will potential output be higher than anticipated but pressures will be relieved on government programs such as Social Security and Medicare. Matheny suggests that the impact could be as large as an additional half of 1 percentage point on potential output growth—but, when all things are considered, through 2017 Matheny's new forecast for potential output growth is only two-tenths of 1 percentage point—2.6 percent per annum versus 2.4 percent—greater than the CBO forecast. In his commentary, Ellis Tallman lauds the detailed level of analysis. In particular, he suggests that such analysis is a royal replacement for the all too commonly used assumptions of fixed or simple trends in labor force participation rates.

POTENTIAL OUTPUT IN A RAPIDLY DEVELOPING ECONOMY: THE CASE OF CHINA AND A COMPARISON WITH THE UNITED STATES AND THE EUROPEAN UNION

China has experienced phenomenal economic growth during the past decade. In this study,

Jinghai Zheng, Angang Hu, and Arne Bigsten examine the sustainability of the growth process. Using the familiar growth accounting framework as their primary analytical tool, they address two major questions. First, to what extent has China's growth been extensive, that is, due primarily to increases in the quantities of inputs, versus intensive, that is, due to increases in total factor productivity? Second, if the growth is extensive, the authors conclude that growth cannot be sustained at its recent pace. The authors build a components-based estimate of potential output within the growth accounting framework and compare that measure with official statistics. They conclude that from 2002-08 the Chinese economy's output was above the measured level of potential—and hence not sustainable. In an innovative analysis, the authors measure the natural resources, or environmental, inputs to China's recent growth, concluding they have been important but that their contribution will diminish as China places new emphasis on the quality of its environment. In his commentary, Ziaodong Zhu notes that China's growth experience perhaps has been more subtle than the authors suggest. In aggregate data, he notes that labor force growth increased sharply during the first half of the reform period, 1978-90, but the investment rate increased little; as a result, the capital-to-output ratio fell. Labor force growth slowed sharply after 1990 and the investment rate increased, allowing steady growth in the capital-to-output ratio. In addition, the period since 1990 has been characterized by shrinkage of the state-owned sector and expansion of the private sector. At the start of the reform period in 1978, the capital-to-output ratio in the state-owned sector exceeded the ratio in the non-state-owned sector, while the marginal product of capital was similar in the two sectors. During the past decade, the state-owned sector experienced a nearly fourfold increase in its capital-to-labor ratio while its share of aggregate employment has increased and the capital-to-labor ratio in the non-state-owned sector approximately doubled. These differences in capital ratios and investment suggest that interpretations and projections of China's growth based on aggregate data may be hazardous.

ESTIMATING U.S. OUTPUT GROWTH WITH VINTAGE DATA IN A STATE-SPACE FRAMEWORK

In the conference's second paper based on vintage data, Richard Anderson and Charles Gascon explore estimating the "true" unobserved level of total output in the U.S. economy via a state-space model in which the true, or potential, output measure is unobserved. This analytical framework has been applied to U.K. data by staff of the Bank of England. Under certain assumptions, Monte Carlo simulations suggest that this framework can improve the accuracy of published estimates (relative to future revisions) by as much as 30 percent for as long as 11 periods. Real-time experiments show improvements closer to 10 percent, primarily during the first and second quarters of publication of revised data for a specific quarter. In his commentary, Dean Croushore explains that Anderson and Gascon's procedure may be defeated by the same aspect of vintage output data that has doomed earlier efforts: The data are subject to significant revisions—breaks—many years in the future, breaks that are difficult to predict in any filtering context. Using data drawn from the Federal Reserve Bank of St. Louis ALFRED database, Croushore explores both CBO projections of potential output and vintage data on output—the impacts of future unforecastable revisions (breaks) are difficult to overstate.

A PANEL DISCUSSION OF POLICYMAKERS

The conference concluded with three policymakers discussing their views and experience regarding the use of potential output in policymaking.

Carlos Araujo of the Central Bank of Brazil surveys the difficulty of using potential output for policy in a developing economy. Data revisions (including changes in methodology) are troublesome, and the length of the Brazilian time series is short. To maximize information extracted from the data, the Bank staff use a wide set of statistical filters and econometric modeling tools, despite

the efficacy of some filtering methods relying on statistical assumptions that are almost the opposite of others. In particular, various estimates are model dependent with disagreement regarding the appropriate model. Measures of potential output and its cousin, the output gap, are very important for policy but also must be recognized as imprecisely estimated.

Seppo Honkapohja of the Bank of Finland emphasizes that "there are two different concepts of the output gap and both are used in monetary policy analysis." The traditional concept, in his view, is the difference between a long-run trend and actual output; the more recent model-based concept is the difference between a model-based flexible price level of output and actual output. He notes that the two concepts are different and can behave in quite different ways through time—but both are used in policymaking. He cautions that model-based policy analysis, while attractive in its rigor and elegance, must be tempered by the shortcomings of the real world, including noisy data, broad issues of imperfect knowledge (including uncertainty regarding the correct model of the economy), and the effects of learning by economic agents.

James Bullard of the Federal Reserve Bank of St. Louis offered a challenge to modelers by arguing that any "trend" or potential output measure must be an integral part of the macro modeling itself. Bullard argues that such a viewpoint is essential throughout the "equilibrium" business cycle literature, including real business cycle, New Keynesian, and multisector growth models, because all equilibrium models are based on a long-run balanced growth path concept, which necessarily has implications for the allowable trends. Specifically, Bullard argues that the current practice in which data are "detrended" by atheoretic, univariate statistical methods is not defensible. Structural breaks are an important part of Bullard's analysis. He argues that empirical studies have shown convincingly that the economy's data-generating process experiences structural shifts. In such an economy, the macroeconomic concept of learnability is crucial—policymakers must recognize that economic agents *do* learn following a shift in trend and that optimal policy reactions are not invariant to the learning process.